

Digital-Based e-Modules in Tarung Derajat Martial Arts Learning at Basic Level

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Abstract Learning media in the form of e-modules is one of the most important indicators in achieving effective and efficient learning objectives, especially in learning the *Tarung Derajat* martial arts. Therefore, this study aims to develop digital-based e-modules in *Tarung Derajat* martial arts learning at the basic level. The design used is research and development with the aim of producing and testing product effectiveness. The development stage consists of product design, product testing, and product implementation. The designed product contains covers, prefaces, menus for e-modules, instructions for use, course descriptions, learning outcomes, operational learning outcomes, learning materials, learning videos, summaries, evaluation questions, scoring systems, and lists of references. Then it was validated by 3 competent experts in their fields, namely material experts, media experts, and curriculum experts. After the product was declared feasible, field implementation was continued with 120 students and 4 lecturers who taught the *Tarung Derajat* martial arts course at the Faculty of Sports Science, Padang State University, Indonesia. The criteria for participants are students who take *Tarung Derajat* martial arts courses at the basic level and an average age of 20.3 years. Evaluation of product feasibility and effectiveness was obtained through a questionnaire, then analyzed using percentages. The results showed that the average validation of experts was 89.44 or very good category. Furthermore, the average result of field implementation is 89.34 or very good category. In conclusion, digital-based e-modules are

effectively used in *Tarung Derajat* martial arts learning at the basic level. This product is expected to be useful for lecturers (teaching staff), *Tarung Derajat* martial arts trainers, and sports students to make it easier for them to achieve effective and efficient learning. Future research is needed at the level of specialization, sample size and sample diversity (athlete level), experts, and more refined design and appearance.

Keywords Martial Arts, *Tarung Derajat*, e-Modules

1. Introduction

Tarung Derajat is a type of martial arts that is quite popular in Indonesia, as well as in the Southeast Asian region (since the 2011 Sea Games in Jakarta). This is also evidenced by the rapid development of training units in regencies or cities from all provinces in Indonesia [1], [2]. This martial art was created by the son of a native of Indonesia "Guru H. Achmad Dradjat", who is known to be quite tough, prioritizes a sense of brotherhood, and teaches all his members (athletes) to train "moral and mental" or is called "*Mortal Ghada*" [3], [4]. The popularity of this martial art has made it one of the subjects taught at tertiary institutions in the sports science faculty, especially in the sports coaching department, Padang State University, Indonesia.

Effective and efficient learning is inseparable from technological support [5], because technology can provide convenience in overcoming limitations in the learning process, such as the use of learning media [6], [7]. Learning media can be used as an intermediary in conveying information (such as text, audio and video) between the giver and the recipient [8], [9]. The use of learning media aims to improve and simplify the learning process [10], [11], thereby helping students understand the material presented [12]. One of the media that meets these criteria is an electronic module (e-module) [12], [13]. E-modules are information and communication technology-based modules that are interactive because of their convenience, display, images, audio, video, animation, and feedback through formative tests and quizzes [14]. Thus, students can study individually at school or at home according to their individual learning pace.

The current phenomenon is that teaching staff have not utilized technology-based learning media to achieve effective and efficient learning objectives. One reason is the limited technology-based support tools [15], [16]. Therefore, a solution is needed by utilizing learning media such as digital-based e-modules. The use of learning media in martial arts has been discussed in previous studies, such as media hyperlinks to learn basic techniques in Wushu [17], social media as a learning aid and preservation of Chinese martial arts in Hong Kong [18], visualize and revitalize traditional Chinese martial arts [19], and investigation of the use of virtual reality in flipped teaching of martial arts Taijiquan based on deep learning and big data analytics [20]. However, until now there has been no study that examines digital-based e-modules in *Tarung Derajat* martial arts learning at the basic level.

Therefore, this study aims to develop a product in the form of a digital-based e-module in *Tarung Derajat* martial arts learning at the basic level. The product developed is expected to be useful for lecturers (teaching staff), *Tarung Derajat* martial arts trainers, and sports students to facilitate them in achieving effective and efficient learning.

2. Materials and Methods

2.1. Study Design

Research and development is used as a design in this study, which aims to produce products and test their effectiveness [21], [22]. The product to be produced is a digital-based e-module in *Tarung Derajat* martial arts learning at the basic level.

2.2. Participant

This study involved 3 experts who were competent in their fields, namely material experts, media experts, and curriculum experts. Then, as many as 120 students and 4 lecturers at the Faculty of Sports Science, Padang State University, Indonesia were used for field trials. The criteria for lecturers are: (1) teaching the *Tarung Derajat* martial arts course, and (2) being willing to voluntarily. While the criteria for students are: (1) students taking basic *Tarung Derajat* martial arts courses, (2) an average age of 20.3 years, and (3) willing to voluntarily.

2.3. Procedure

2.3.1. Product design

At this stage, the design of digital-based e-modules was carried out in *Tarung Derajat* martial arts learning at the basic level. The development of the e-module is based on the syllabus and semester learning plans in the *Tarung Derajat* martial arts course at the basic level (Table 1). The product design components consist of covers, prefaces, menus for e-modules, instructions for use, course descriptions, learning outcomes, operational learning outcomes, learning materials, learning videos, summaries, evaluation questions, scoring systems, and lists of references.

Table 1. Syllabus and semester learning plans for the *Tarung Derajat* martial arts course at the basic level

Meeting	Planned capabilities	Study material
1	Introduction to lectures	Syllabus contract
		Synopsis of the <i>Tarung Derajat</i> martial arts course
		Course goals/objectives
2-3	Rules and conditions	History, philosophy, martial arts organization <i>Tarung Derajat</i>
		Basic standby (stance).
		Respect
		Posture, sitting and standing
		Way forward and backward
		Stepping left and right
4	Various kinds of standby (horses) in the <i>Tarung Derajat</i> martial arts	Standby on the spot
		Cross alert
		Kick standby/kick position
		Fight alert
5	Materials/basic techniques of hands and feet in standby on the spot	Straight punch: One straight punch Two straight punches Three straight punches
		Elbow: Upper elbow Side elbow Lower elbow
		Flick: Top flick Flick outside Down flick Deep flick
		Kick: Top kick Down kick
		Fast punches and fast doubles
		Straight kick
6	Punch and kick techniques in a cross alert position, forward, backward, facing left, facing right, and turning	Straight punch
		Elbow
		Flick
		Kick shot
		Fast punch
		Straight kick
7	Mandatory art of basic step movement	The series of mandatory art moves are basic steps in 36 counts
8	Mid semester exam	Meeting materials 1-7
9-10	Basic hand and foot techniques for kurata II advanced level	Upper elbow and side elbow
		Inside kick, side kick and back kick
		Two-motion technique
11-13	Defense and attack techniques	Materials for survival (1-12)
		The staple for attacking in a cross alert position, striking forward with straight punches
14-15	Mandatory art of movement	Mandatory kick of basic steps
16	Final exams	All material

2.3.2. Product testing

Products that have been designed are validated by experts who are competent in their fields, namely material experts, media experts, and curriculum experts. This aims to determine the level of validity and product deficiencies before being implemented into the field.

2.3.3. Product implementation

After the product is declared feasible, it is continued with field implementation to determine the effectiveness of the product being developed. This trial was conducted on 120 students and 4 lecturers who taught the *Tarung Derajat* martial arts course at the Faculty of Sports Science, Padang State University, Indonesia.

2.4. Instruments

The questionnaire is used to test the feasibility and effectiveness of the product being developed. The total number of statements is 35 items, each of which is 10 items for material experts, 12 items for media experts, 3 items for curriculum experts, and 10 items for product implementation. This questionnaire was filled out by experts after conducting an assessment of the product being developed (Table 2). As for product implementation, it is filled in by lecturers and students after being implemented in the *Tarung Derajat* martial arts lecture process at the basic level (Table 3).

Table 2. Product validation questionnaire

The experts	Assessment indicators
Material expert	The relevance of the material to the <i>Tarung Derajat</i> martial arts lesson plan at the basic level
	The material presented is structured and systematic
	The accuracy of sentence structure and language that is easy to understand
	The material is in accordance with the formulated study
	The material is presented according to the level of student ability in the <i>Tarung Derajat</i> martial arts course at the basic level
	Clarity of description of each material
	The scope of material relates to <i>Tarung Derajat</i> martial arts lectures at the basic level
	The material for each meeting is very clear and detailed
	The pictures used are in accordance with the material presented
	The videos presented are in accordance with the material
Media expert	Text is legible and clear
	Graphic selection
	Text size and font type
	Colors and graphics
	Supporting image
	Animation display
	Video view
	Audio is heard clearly
	Clarity of material description
	Clarity of instructions
	Placement and use of buttons
Media use	
Curriculum expert	Expertise design (formulation of graduate learning outcomes, formation of courses)
	Design of learning tools (identity, course descriptions, learning outcomes, operational learning outcomes, assessment systems, assessment ranges, references)
	Preparation of assessment instruments

Table 3. Product implementation questionnaire

Subject	Assessment indicators
Lecturers and students	The design of <i>Tarung Derajat</i> martial arts learning media at the basic level is very interesting
	The use of <i>Tarung Derajat</i> martial arts learning media at the basic level is very easy and practical
	The <i>Tarung Derajat</i> self-defense learning video at the basic level is very effective in mastering the material
	The design of <i>Tarung Derajat</i> martial arts learning media at the basic level can help students understand each of the material
	The <i>Tarung Derajat</i> martial arts learning media at the basic level is more motivating for students in learning each material
	The material in the <i>Tarung Derajat</i> martial arts learning media at the basic level is related to the lesson plan
	The material presented in the <i>Tarung Derajat</i> martial arts learning media at the basic level is easier to understand
	The <i>Tarung Derajat</i> martial arts learning media at the basic level contains learning videos that test student understanding from each meeting
	Presentation of movement material in the <i>Tarung Derajat</i> martial arts learning media at the basic level can help students learn basic technical movements
	The shape, model, and size of the letters used in the <i>Tarung Derajat</i> martial arts learning media at the basic level are very easy to read

The indicators for assessing the questionnaire consist of 5 alternative answers, namely very good (score 5), good (score 4), enough (score 3), less (score 2), and very less (score 1). Then, the results of the overall answers are categorized as follows: 81-100% for the very good category, 61-80% for the good category, 41-60% for the enough category, 21-40% for the less category, and 0-20% for the very less category [23].

2.5. Statistical Analysis

Assessment of the feasibility and effectiveness of the product developed is analyzed using a percentage (achievement score/maximum score*100%).

3. Result

3.1. Product Validation

Product validation was carried out by 3 experts who were competent in their fields, namely material experts, media experts, and curriculum experts (Table 4). This is done to determine the level of feasibility and product deficiencies before being implemented in the field.

Table 4 shows that the overall average validation results of experts are 89.44 or very good category. Each is 90.00 for material experts, 85.00 for media experts, and 93.33 for curriculum experts (Figure 1). Correction from experts for improvement before field implementation (item at score 3 or enough category) is part material at each meeting and is presented in more detail (material experts), and the display of material descriptions is more designed to make it more attractive (media experts). Thus, as a whole, digital-based e-modules in *Tarung Derajat* martial arts learning at for the basic level are feasible to implement in the field.

Table 4. Expert validation results

Material expert	Score	%
The relevance of the material to the <i>Tarung Derajat</i> martial arts lesson plan at the basic level	5	100.00
The material presented is structured and systematic	5	100.00
The accuracy of sentence structure and language that is easy to understand	4	80.00
The material is in accordance with the formulated study	5	100.00
The material is presented according to the level of student ability in the <i>Tarung Derajat</i> martial arts course at the basic level	5	100.00
Clarity of description of each material	5	100.00
The scope of material relates to <i>Tarung Derajat</i> martial arts lectures at the basic level	4	80.00
The material for each meeting is very clear and detailed	3	60.00
The pictures used are in accordance with the material presented	5	100.00
The videos presented are in accordance with the material	4	80.00
Achievement score	45	
Maximum score	50	
Results (%)	90.00	
Media expert	Score	%
Text is legible and clear	5	100.00
Graphic selection	4	80.00
Text size and font type	4	80.00
Colors and graphics	5	100.00
Supporting image	5	100.00
Animation display	4	80.00
Video view	4	80.00
Audio is heard clearly	5	100.00
Clarity of material description	3	60.00
Clarity of instructions	4	80.00
Placement and use of buttons	4	80.00
Media use	4	80.00
Achievement score	51	
Maximum score	60	
Results (%)	85.00	
Curriculum expert	Score	%
Expertise design (formulation of graduate learning outcomes, formation of courses)	5	100.00
Design of learning tools (identity, course descriptions, learning outcomes, operational learning outcomes, assessment systems, assessment ranges, references)	4	80.00
Preparation of assessment instruments	5	100.00
Achievement score	14	
Maximum score	15	
Results (%)	93.33	
Average percentage level of experts (%)	89.44 (Very good)	

3.2. Product Implementation

After the product feasibility test and revisions were carried out, it was continued with field trials to determine the effectiveness of the product as a digital-based e-module in *Tarung Derajat* martial arts learning at the basic level. This stage was carried out on 120 students and 4 lecturers who taught the *Tarung Derajat* martial arts course at the

Faculty of Sports Science, Padang State University, Indonesia (Table 5).

Table 5 shows that the overall average results from product implementation are 89.34 or very good categories. Each is 89.50 for lecturers and 89.18 for students (Figure 1). Thus, digital-based e-modules are effectively used in *Tarung Derajat* martial arts learning at the basic level.

Table 5. Product implementation results

Implementation	Lecturers (n=4)		Students (n=120)	
	Score	%	Score	%
The design of <i>Tarung Derajat</i> martial arts learning media at the basic level is very interesting	17	85.00	502	83.67
The use of <i>Tarung Derajat</i> martial arts learning media at the basic level is very easy and practical	19	95.00	552	92.00
The <i>Tarung Derajat</i> self-defense learning video at the basic level is very effective in mastering the material	17	85.00	523	87.17
The design of <i>Tarung Derajat</i> martial arts learning media at the basic level can help students understand each of the material	18	90.00	559	93.17
The <i>Tarung Derajat</i> martial arts learning media at the basic level is more motivating for students in learning each material	18	90.00	511	85.17
The material in the <i>Tarung Derajat</i> martial arts learning media at the basic level is related to the lesson plan	19	95.00	528	88.00
The material presented in the <i>Tarung Derajat</i> martial arts learning media at the basic level is easier to understand	17	85.00	504	84.00
The <i>Tarung Derajat</i> martial arts learning media at the basic level contains learning videos that test student understanding from each meeting	18	90.00	534	89.00
Presentation of movement material in the <i>Tarung Derajat</i> martial arts learning media at the basic level can help students learn basic technical movements	17	85.00	560	93.33
The shape, model, and size of the letters used in the <i>Tarung Derajat</i> martial arts learning media at the basic level are very easy to read	19	95.00	578	96.33
Achievement score	179		5351	
Maximum score	200		6000	
Results (%)	89.50		89.18	
Average implementation rate (%)	89.34 (Very good)			

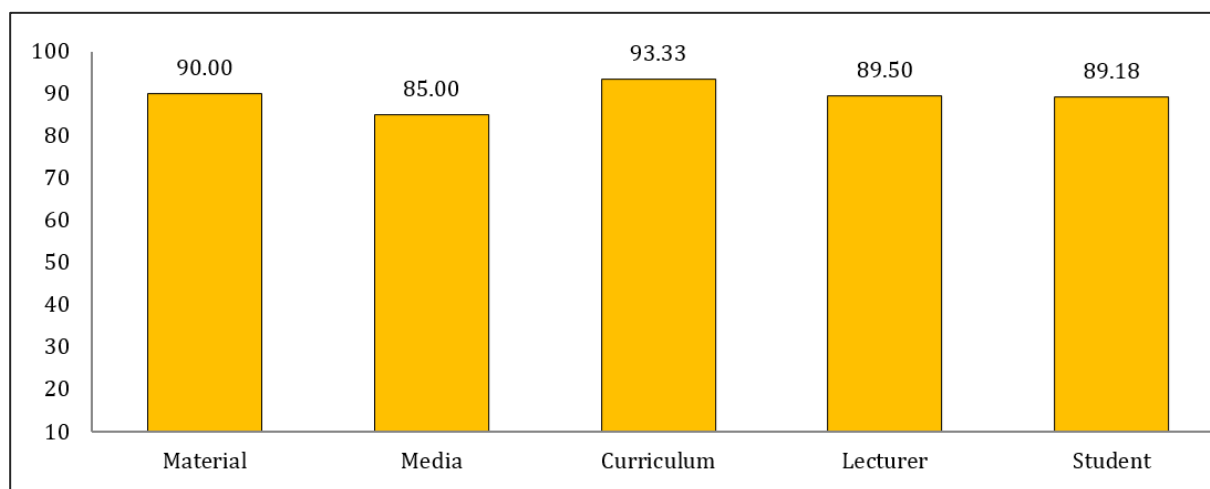


Figure 1. Percentage of expert validation and product implementation

4. Discussion

Based on the results of this product development, that the overall average of the validation experts is 89.44 or very good category. Furthermore, the overall average of field implementation is 89.34 or very good category. Thus, digital-based e-modules are effectively used in *Tarung Derajat* martial arts learning at the basic level. The results of this study are in accordance with previous studies, the use of technology in education can help the learning process to develop, process, and present material, thus creating a learning atmosphere that arouses students' interest and learning motivation [24]. Other studies also report that technology in learning is a tool used to help success in learning [25], change the learning process to be interesting [26], and motivating [27], [28], so that it has an impact on the activity of students [29], [30]. Other studies also report that technology is widely used to enhance and support training, as well as developing elite and amateur sports [31]–[33].

The use of technology in learning is highly recommended to improve optimal learning outcomes. This has been done for a long time by developed countries (such as England, Germany, France, the United States and other countries), they continue to develop interactive learning media [34], [35]. Previous studies reported that technological developments in learning require educators to develop more effective and efficient learning media [36]. Other studies also report that online instructional formats such as e-modules and computer-based simulation programs can enhance knowledge [37]–[39], skills [40], [41], and promote opportunities for flexible learning at a low cost [42].

The learning process is not just traditional (conventional). A teacher must be able to follow technological developments and use them so that learning is more effective and efficient [43]. In addition, programs that are structured appropriately will have an impact on what has been intended [44], [45]. Thus, the support of technology in sports is very important in achieving optimal performance [21].

Based on these findings, we realize that there are some limitations that need to be validated for future research. This product is only focused on students taking *Tarung Derajat* martial arts courses at the basic level, so it has not been carried out at the level of specialization or *Tarung Derajat* martial arts athletes in general. The sample used is students (average age 20.3 years), so it does not involve younger ages (such as the *Tarung Derajat* martial arts athletes at the senior high school level or aged 16-19 years). Sample size and diversity, as well as limited expertise. Then, the appearance and design of the e-module are still simple.

5. Conclusions

The conclusion from the results of this study is the

creation of a product in the form of a digital-based e-module in *Tarung Derajat* martial arts learning at the basic level. This product has been tested to be feasible and effective for use in *Tarung Derajat* martial arts learning at the basic level. This is in accordance with the results of the average validation of experts 89.44 or very good category and field implementation 89.34 or very good category. This product is expected to be useful for lecturers (teaching staff), *Tarung Derajat* martial arts trainers, and sports students to make it easier for them to achieve effective and efficient learning. Future research is needed at the level of specialization, sample size and sample diversity (athlete level), experts, and more refined design and appearance.

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Conflict of Interest

The authors declare no potential conflicts of interest.

REFERENCES

- [1] Alnedral, S. Bakhtiar, and Umar, "Strategies to improve intelligent characters and fighting ability of self-defense athletes of Tarung Derajat," *Int. J. Mech. Eng. Technol.*, vol. 9, no. 11, pp. 1003–1013, 2018, [Online]. Available: <http://repository.unp.ac.id/id/eprint/27798>.
- [2] Alnedral, S. Bakhtiar, Umar, and N. Aldani, "Training method and excellent characters of basic technique engineering skills," in *International Conference on Sport Science, Health and Recreation (ICoSHR)*, 2018, pp. 3–13, [Online]. Available: <http://repository.unp.ac.id/id/eprint/21005>.
- [3] Alnedral, R. Irawan, and Umar, "Improving thinking mind, feeling, attitude, acting, and responsible for Tarung Derajat (West Java tradisional martial art) Athlete," 2017, [Online]. Available: <http://repository.unp.ac.id/id/eprint/21003>.
- [4] Alnedral, S. Bakhtiar, and Umar, "Training method and excellent character of athletes towards basic skills of Tarung Derajat," in *Proceedings of the 1st Progress in Social Science, Humanities and Education Research Symposium (PSSHRS 2019) Advances in Social Science, Education and Humanities Research*, 2019, vol. 464, pp. 373–376, [Online]. Available: <https://doi.org/10.2991/assehr.k.200824.089>.
- [5] K. Warburton, "Deep learning and education for sustainability," *Int. J. Sustain. High. Educ.*, vol. 4, no. 1, pp. 44–56, 2003, [Online]. Available: <https://doi.org/10.1108/14676370310455332>.

- [6] S. Açışlı, S. A. Yalçın, and Ü. Turgut, "Effects of the 5E learning model on students' academic achievements in movement and force issues," *Procedia - Soc. Behav. Sci.*, vol. 15, pp. 2459–2462, 2011, [Online]. Available: <https://doi.org/10.1016/j.sbspro.2011.04.128>.
- [7] M. Misbah *et al.*, "The effectiveness of introduction to nuclear physics e-module as a teaching material during covid-19 pandemic," *J. Phys. Conf. Ser.*, vol. 1760, no. 1, pp. 1–6, 2021, [Online]. Available: <https://doi.org/10.1088/1742-6596/1760/1/012052>.
- [8] D. Buckingham, "Media education goes digital: An introduction," *Learn. Media Technol.*, vol. 32, no. 2, pp. 111–119, 2007, [Online]. Available: <https://doi.org/10.1080/17439880701343006>.
- [9] S. E. Smaldino, D. L. Lowther, and C. Mims, *Instructional technology and media for learning*. New Jersey: Pearson Education, 2005.
- [10] M. Conway, "Exploring the implications, challenges and potential of new media and learning," *Horiz.*, vol. 19, no. 4, pp. 245–252, 2011, [Online]. Available: <https://doi.org/10.1108/10748121111179367>.
- [11] B. de Siqueira, A. Berardi, J. Mistry, and D. Rothberg, "Experimenting with media education, civic engagement, and sustainability in Brazilian schools," *Commun. Inf. Technol. Annu.*, vol. 12, no. 1, pp. 41–61, 2016, [Online]. Available: <https://doi.org/10.1108/s2050-20602016000012004>.
- [12] H. Komikesari, M. Mutoharoh, P. S. Dewi, G. N. Utami, W. Anggraini, and E. F. Himmah, "Development of e-module using flip pdf professional on temperature and heat material," *J. Phys. Conf. Ser.*, vol. 1572, no. 1, pp. 1–10, 2020, [Online]. Available: <https://doi.org/10.1088/1742-6596/1572/1/012017>.
- [13] E. A. Munthe, S. Silaban, and Z. Muchtar, "Discovery learning based e-module on protein material development," *Adv. Soc. Sci. Educ. Humanit. Res.*, vol. 384, pp. 604–607, 2019, [Online]. Available: <https://doi.org/10.2991/aisteel-19.2019.137>.
- [14] R. Voithofer, "Designing new media education research: The materiality of data, representation, and dissemination," *Educ. Res.*, vol. 34, no. 9, pp. 3–14, 2005, [Online]. Available: <https://doi.org/10.3102/0013189X034009003>.
- [15] N. Ihsan, Yulkifli, and Yohandri, "Development of speed measurement system for Pencak Silat kick based on sensor technology," *J. Phys. Conf. Ser.*, vol. 180, no. 1, pp. 1–8, 2017, [Online]. Available: <https://iopscience.iop.org/article/10.1088/1757-899X/180/1/012171/meta>.
- [16] Komaini *et al.*, "Motor learning measuring tools: A design and implementation using sensor technology for preschool education," *Int. J. Interact. Mob. Technol.*, vol. 15, no. 17, pp. 177–191, 2021, [Online]. Available: <https://doi.org/10.3991/ijim.v15i17.25321>.
- [17] J. N. Ibrahim and S. Muslim, "Develop of hyperlinks media to learn basic Wushu," *J. Comput. Theor. Nanosci.*, vol. 17, pp. 825–832, 2020, [Online]. Available: <https://doi.org/10.1166/jctn.2020.8725>.
- [18] M. Y. C. Mak, A. Y. M. Poon, and D. K. W. Chiu, "Using social media as learning aids and preservation: Chinese martial arts in Hong Kong," *Digit. Folk. Cyberculture Digit. Humanit.*, pp. 171–185, 2022, [Online]. Available: <https://doi.org/10.4018/978-1-6684-4461-0.ch010>.
- [19] P. Lo *et al.*, "Visualising and revitalising traditional Chinese martial arts: Visitors' engagement and learning experience at the 300 years of Hakka Kungfu," *Libr. Hi Tech*, vol. 37, no. 2, pp. 273–292, 2019, [Online]. Available: <https://doi.org/10.1108/lht-05-2018-0071>.
- [20] Z. Hanliang and Z. Lina, "Investigation on the use of virtual reality in the flipped teaching of martial arts Taijiquan based on deep learning and big data analytics," *J. Sensors*, pp. 1–14, 2022, [Online]. Available: <https://doi.org/10.1155/2022/3921842>.
- [21] K. Firdaus and D. T. Mario, "Development of service sensor tools on table tennis net," *J. Phys. Educ. Sport*, vol. 22, no. 6, pp. 1449–1456, 2022, [Online]. Available: <https://doi.org/10.7752/jpes.2022.06182>.
- [22] Komaini, Hermanzoni, S. G. Handayani, M. S. Rifki, Y. Kiram, and N. Ayubi, "Design of children's motor training tools using sensor-based agility components in physical education learning," *Int. J. Interact. Mob. Technol.*, vol. 16, no. 05, pp. 207–215, 2022, [Online]. Available: <https://doi.org/10.3991/ijim.v16i05.29731>.
- [23] Z. Z. Zulfahri, S. Sepriadi, D. T. Mario, Y. Astuti, and F. Amra, "Digital-based gymnastics learning media for rolling front round material: Direct and indirect assistance approaches," *J. Sport Area*, vol. 7, no. 3, pp. 415–424, 2022, [Online]. Available: <https://journal.uir.ac.id/index.php/JSP/article/view/10736>.
- [24] Aremu and B. M. Efuwape, "A microsoft learning content development system (LCDS) based learning package for electrical and electronics technology-issues on acceptability and usability in Nigeria," *Am. J. Educ. Res.*, vol. 1, no. 2, pp. 41–48, 2013, [Online]. Available: <https://doi.org/10.12691/education-1-2-2>.
- [25] Z. Z. Shoraevna, Z. A. Eleupanovna, S. N. Tashkenbaevna, Z. Zulkarnayeva, L. L. Anatolevna, and U. A. Nurlanbekovna, "Teachers' views on the use of information and communication technologies (ICT) in education environments," *Int. J. Emerg. Technol. Learn.*, vol. 16, no. 3, pp. 261–273, 2021, [Online]. Available: <https://doi.org/10.3991/ijet.v16i03.18801>.
- [26] N. C. Burbules, G. Fan, and P. Repp, "Five trends of education and technology in a sustainable future," *Geogr. Sustain.*, vol. 1, pp. 93–97, 2020, [Online]. Available: <https://doi.org/10.1016/j.geosus.2020.05.001>.
- [27] C. J. Gómez-Carrasco, J. Monteagudo-Fernández, J. R. Moreno-Vera, and M. Sainz-Gómez, "Evaluation of a gamification and flipped-classroom program used in teacher training: Perception of learning and outcome," *PLoS One*, vol. 15, no. 7 July, pp. 1–19, 2020, [Online]. Available: <https://doi.org/10.1371/journal.pone.0236083>.
- [28] R. Schmid and D. Petko, "Does the use of educational technology in personalized learning environments correlate with self-reported digital skills and beliefs of secondary-school students?," *Comput. Educ.*, vol. 136, pp. 75–86, 2019, [Online]. Available: <https://doi.org/10.1016/j.compedu.2019.03.006>.
- [29] D. Oluwajana, A. Idowu, M. Nat, V. Vanduhe, and S. Fadiya, "The adoption of students' hedonic motivation system model to gamified learning environment," *J. Theor.*

- Appl. Electron. Commer. Res.*, vol. 14, no. 3, pp. 156–167, 2019, [Online]. Available: <https://doi.org/10.4067/S0718-18762019000300109>.
- [30] M. Ninaus *et al.*, “Increased emotional engagement in game-based learning – A machine learning approach on facial emotion detection data,” *Comput. Educ.*, vol. 142, pp. 1–10, 2019, [Online]. Available: <https://doi.org/10.1016/j.compedu.2019.103641>.
- [31] V. Camomilla, E. Bergamini, S. Fantozzi, and G. Vannozi, “Trends supporting the in-field use of wearable inertial sensors for sport performance evaluation: A systematic review,” *Sensors*, vol. 18, no. 3, pp. 1–50, 2018, [Online]. Available: <https://doi.org/10.3390/s18030873>.
- [32] S. T. Matsuwaka and E. W. Latzka, “Summer adaptive sports technology, equipment, and injuries,” *Sports Med. Arthrosc.*, vol. 27, no. 2, pp. 48–55, 2019, [Online]. Available: <https://doi.org/10.1097/JSA.0000000000000231>.
- [33] H. Oh, W. Johnson, and I. P. Syrop, “Winter adaptive sports participation, injuries, and equipment,” *Sports Med. Arthrosc.*, vol. 27, no. 2, pp. 56–59, 2019, [Online]. Available: <https://doi.org/10.1097/JSA.0000000000000236>.
- [34] B. N. R. Putra, A. Mukhadis, N. Ulfatin, Tuwoso, M. S. Subandi, and Hardika, “The innovation of disruptive learning media with augmented reality based 3D object concept with drill machine de ...,” *Int. J. Interact. Mob. Technol.*, vol. 15, no. 12, pp. 193–201, 2021, [Online]. Available: <https://doi.org/10.3991/ijim.v15i12.21579>.
- [35] Tuwoso, A. B. N. R. Putra, A. Mukhadis, Purnomo, A. K. Bin Mahamad, and M. S. Subandi, “The technology of augmented reality based on 3D modeling to improve special skills for vocational students in the era of industrial revolution 4.0,” *J. Phys. Conf. Ser.*, vol. 1833, no. 1, pp. 0–7, 2021, [Online]. Available: <https://doi.org/10.1088/1742-6596/1833/1/012010>.
- [36] F. E. Doloksaribu and T. Triwiyono, “The reconstruction model of science learning based phet-problem solving,” *Int. J. Stud. Educ.*, vol. 3, no. 1, pp. 37–47, 2020, [Online]. Available: <https://doi.org/10.46328/ijonse.30>.
- [37] D. A. Cook, A. J. Levinson, S. Gaarside, D. M. Dupras, P. J. Erwin, and V. M. Montori, “Internet-based learning in the health professions,” *JAMA*, vol. 300, no. 10, pp. 1181–1196, 2008, [Online]. Available: <https://doi.org/10.1001/jama.300.10.1181>.
- [38] J. G. Ruiz, M. J. Mintzer, and R. M. Leipzig, “The impact of e-learning on medical education,” *Acad. Med.*, vol. 81, no. 3, pp. 207–212, 2006, [Online]. Available: <https://doi.org/10.2304/elea.2011.8.1.31>.
- [39] T. Sitzmann, K. Kraiger, D. Stewart, and R. Wisher, “The comparative effectiveness of web-based and classroom instruction: A meta-analysis,” *Pers. Psychol.*, vol. 59, pp. 623–664, 2006, [Online]. Available: <https://doi.org/10.1111/j.1744-6570.2006.00049.x>.
- [40] D. A. Cook *et al.*, “Technology-enhanced simulation for health professions education,” *JAMA*, vol. 306, no. 9, pp. 978–988, 2011, [Online]. Available: <https://doi.org/10.1001/jama.2011.1234>.
- [41] W. C. McGaghie, S. B. Issenberg, E. R. Petrusa, and R. J. Scalese, “A critical review of simulation-based medical education research: 2003–2009,” *Med. Educ.*, vol. 44, no. 1, pp. 50–63, 2010, [Online]. Available: <https://doi.org/10.1111/j.1365-2923.2009.03547.x>.
- [42] M. E. W. Dankbaar and P. G. M. de Jong, “Technology for learning: how it has changed education,” *Perspect. Med. Educ.*, vol. 3, no. 4, pp. 257–259, 2014, [Online]. Available: <https://doi.org/10.1007/s40037-014-0141-0>.
- [43] A. Hussin, “Education 4.0 made simple: Ideas for teaching,” *Int. J. Educ. Lit. Stud.*, vol. 6, no. 3, pp. 92–98, 2018.
- [44] D. T. Mario, A. Komaini, W. Welis, E. Sepdanius, and D. Syafrianto, “High-protein foods in weight training as an alternative for muscle hypertrophy: Soy milk, egg whites, and tofu,” *J. Phys. Educ. Sport*, vol. 22, no. 9, pp. 2254–2264, 2022, [Online]. Available: <https://doi.org/10.7752/jpes.2022.09287>.
- [45] D. T. Mario *et al.*, “Slow-motion in weight training: How does it affect muscle hypertrophy in untrained young men?,” *J. Phys. Educ. Sport*, vol. 22, no. 10, pp. 2465–2471, 2022, [Online]. Available: <https://doi.org/10.7752/jpes.2022.10314>.